

REMARKS

New claim 30 is supported by claim 6.

The undersigned thanks the Examiner for the courtesies extended during the telephone interview of May 16, 2007. During the interview, the undersigned explained that the Examiner's position that Aksay teaches the claimed method directed to molecular combining *of a biomolecule* wherein the molecular combining comprises attachment of the biomolecule to a surface and alignment of the biomolecule is incorrect. The undersigned explained that Aksay teaches a method of making "[a] process directed to preparing surfactant-polycrystalline *inorganic nanostructured materials* having designed microscopic patterns" (see abstract, lines 1-3, of Aksay; emphasis added) that mimic natural structures found in nature, but it does not teach the claimed method directed analyzing a biomolecule.

The Examiner stated that he has broadly interpreted "biomolecule," and stated a definition of "biomolecule" from the Internet to mean "any organic molecule that is an essential part of a living organism." See "Definitions of Biomolecule on the Web" at http://www.google.com/search?hl=en&defl=en&q=define:Biomolecule&sa=X&oi=glossary_definition&ct=title. The undersigned explained that even by this broad definition of "biomolecule" from the web, the "surfactant-polycrystalline *inorganic nanostructured materials* having designed microscopic patterns" (see abstract, lines 1-3, of Aksay; emphasis added) are outside the scope of the claimed invention because "inorganic nanostructured materials" are not "any organic molecule that is an essential part of a living organism."

The undersigned also explained that all of the portions of Aksay cited by the Examiner only relate to making *inorganic* nanostructures that *mimic* products of nature, but do not relate to molecular combining *of a biomolecule* wherein the *molecular combining* comprises attachment of the biomolecule to a surface and alignment of the biomolecule. In fact, nowhere does Aksay disclose molecular combining of any material whatsoever. The undersigned explained that the first inventor of Aksay is Professor Ilhan A. Aksay, Professor of Chemical Engineering and Ceramics Materials Laboratory, Princeton University. See attached Exhibit 1. Professor Aksay's research is

Paragraph [0055] relates to “growth of a mesostructured *inorganic*,” and “a mesostructured *inorganic*” is not a “biomolecule” even by the Examiner’s definition of a biomolecule to mean “any organic molecule that is an essential part of a living organism.”

[0004] Biologically produced inorganic-organic composites such as bone, teeth, diatoms, and sea shells are fabricated through highly coupled (and often concurrent) synthesis and assembly. These structures are formed through template-assisted self-assembly, in which self-assembled organic material (such as proteins, or lipids, or both) form the structural scaffolding for the deposition of inorganic material. They are hierarchically structured composites in which soft organic materials are organized on length scales of 1 to 100 nm and used as frameworks for specifically oriented and shaped inorganic crystals (that is, ceramics such as hydroxyapatite, CaCO_3 , SiO_2 , and Fe_3O_4). In some cases, structurally organized organic surfaces catalytically or epitaxially induce growth of specifically oriented inorganic thin films.

Abstract, first 10 lines, of Aksay states:

{W:\21058\1206449-US1\01106337.DOC 1206449-1}

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Dated: May 24, 2007

Respectfully submitted,

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Exhibit 1

Department of Chemical Engineering

People: Faculty

Ilhan A. Aksay

Professor

B.S., Ceramic Engineering,
University of Washington, 1967
M.S., Materials Science and Engineering,
University of California at Berkeley, 1969
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Honors and Awards

- National (Turkish) Medal of Science, Tubitak, Turkey, 2001
- Edward C. Henry Award, the American Ceramic Society, 2000
- Charles M.A. Stine Award, American Institute of Chemical Engineers, 1997
- Richard M. Fulrath Award, American Ceramic Society, 1987

Concurrent University Appointments

- Associated Faculty, Department of Civil and Environmental Engineering
- Associated Faculty, Department of Mechanical and Aerospace Engineering
- Associated Faculty, Princeton Environmental Institute

Publications

Research Interests

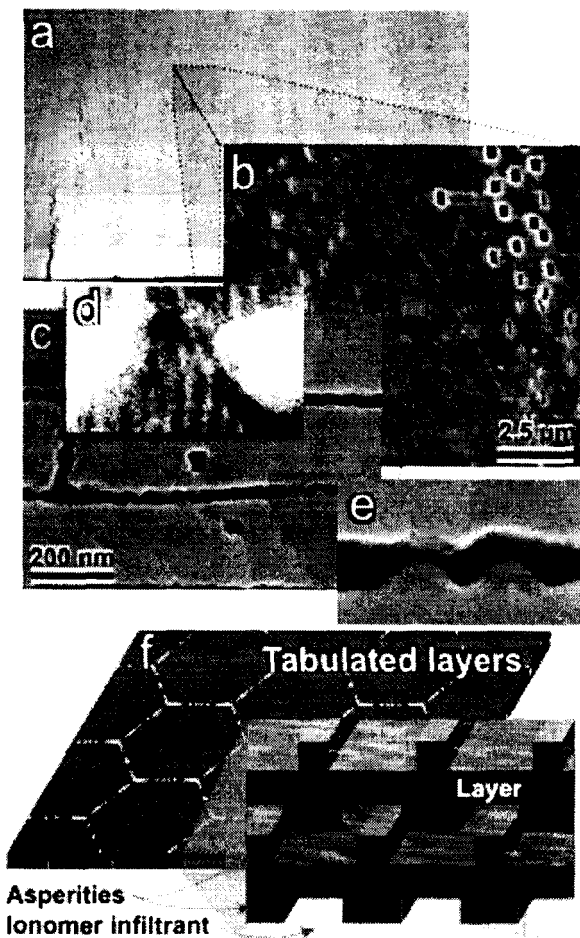
Materials processing with complex fluids is the central theme of our research activities. Complex fluids such as colloids and/or amphiphilic solutions spontaneously self-assemble to produce ordered nanostructures, an essential step in the design and processing of materials [D.M. Dabbs, I.A. Aksay, *Annu. Rev. Phys. Chem.* **51** 601 (2000)]. Many of our activities draw inspiration from biological systems (see following figure) [R.Z. Wang, Z. Suo, A.G.

Evans, N. Yao, I.A. Aksay, *J. Mater. Res.* **16** 2485 (2001)]. Like the biological analogs that provide inspiration, our goal is to shape new systems that are multifunctional, "smart" in their ability to detect and respond to changes in environmental conditions, and capable of self-healing.

Guided self-assembly of nanostructured composites. Although self-assembly provides locally ordered nanostructures similar to those observed in biological systems, global order is not attained due to the statistical nature of the ordering process. We explore the role of electrohydrodynamic effects to guide the global order by a variety of techniques that have derived their fundamental understanding from joint studies with D.A. Saville [W.D. Ristenpart, I.A. Aksay, D.A. Saville, *Phys. Rev. Lett.* **90** 128303 (2003)]. Colloidal patterning through cone-jet printing is one technique that offers the potential to produce patterns at the nanometer scale rapidly and over large areas.

Self-healing materials. Man-made materials lack the ability for self-repair; whereas biologically produced materials sense and repair defects through cellular activities. Concepts generated from model studies provide new approaches for the development of man-made materials with self-repair functions. Our synthetic analogs are built with arrays of microreactors through pixelated structures similar to those used in LCD technology. For instance, when an organic/inorganic hybrid coating is damaged, the damaged region heals spontaneously [N. Yao, A.Y. Ku, H. Nakagawa, T. Lee, D.A. Saville, I.A. Aksay, *Chem. Mater.* **12** 1536 (2000)]. Further, the rate of self-repair is enhanced with the application of weak electrical fields ($\sim 10^2$ V/m). In a second example, we partially mimic the process of blood clotting as a process of colloidal aggregation at a defect site. We then make this a permanent protective layer, for instance, through the electrodeposition of a metal binder in the interstitials of the colloidal aggregate. In both approaches the mechanisms are not yet fully understood.

Microsensors and actuators. Our goal is to develop arrays of piezoelectric microcantilevers (e.g., PbO-ZrO₂-TiO₂ (PZT)) that replicate the process of gathering physical and chemical metrics *in vivo*. We explore the feasibility of using arrays of nanocomposite microcantilevers [C.R. Martin, I.A. Aksay, *J. Phys. Chem. B* **107** 4261 (2003)] as biosensors that are capable of simultaneously measuring, in real time, multiple biophysical and biochemical properties of fluids in the human body [W.Y. Shih, X. Li, H. Gu, W.-H. Shih, I.A. Aksay, *J. Appl. Phys.* **89** 1497 (2001)]. A nanostructured coating (L₃ templated silica) gives enhanced sensitivity due to the presence of features from 5 to 30 nm in size that, in turn, give rise to a large effective surface-area (>1000 m²/g).



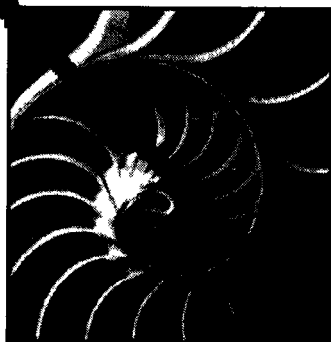
(a, b, c) Tabular and layered structure of nacre from abalone shown at three magnifications. (d, e) Distributed deformation, displayed by the opening of gaps between all tablets by a fixed strain, is regulated through nanoscaled pillars (d) and asperities (e). (f) A synthetic model.

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CERAMIC MATERIALS
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princeton.edu/~em1/htm1/re



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length scales of 1-100 nm function as frameworks for the growth of specifically oriented and shaped inorganics (e.g., CaCO_3 , SiO_2 , Fe_3O_4 , hydroxyapatite) with small unit cells. The high modulus inorganic phase provides the stiffness while the organic phase enhances toughness. Although the principle of hierarchical design has been applied to synthetic composites, the smallest length scale readily accessible is on the micron scale.

The Ceramics Materials Laboratory is interested in refining existing techniques and developing new ones which allow structural control at a variety of length scales from nanometer to macroscopic. Active research areas include **Self-Assembly and Patterning**, **Self-Healing Materials**, and **Biosensors**.

II. Self-assembly and Templating Processes

Biological systems are known to self-assemble into organized structures at many length scales. At the smallest levels, the resulting structures sometimes act as templates for the growth of other materials. The end result is a layered composite with several levels of structural organization. For example, the structure of an abalone shell consists of layered plates of CaCO_3 (~200 nm) held together by a much thinner (<10 nm) "mortar" of organic template. Our interest in the structural properties of seashell is described in the project *Mechanical Properties of Seashell*.

Another class of biogenic materials in which self-assembly and templating lead to a macroscopic materials system of specialized application is bone. In the project **Bone Implant Technology**, we seek to use the techniques of rapid prototyping to tailor bone implants with composition and structure similar to those of natural bone.

III. Structure-property relationship modeling

A host of structure-property models exist to describe the mechanical, electromagnetic, optical and other properties of material systems. However, the biologically-inspired introduction of structural order at multiple length scales presents a problem. Since many material properties (e.g., fracture) do not scale linearly with size, structure at the nanometer scale leads to properties fundamentally different from those based on simple mixing rules or extrapolation from the bulk properties of the constituents.



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